USE SILSUITE SILCALC RESULTS IN EXSILENTIA SILVER

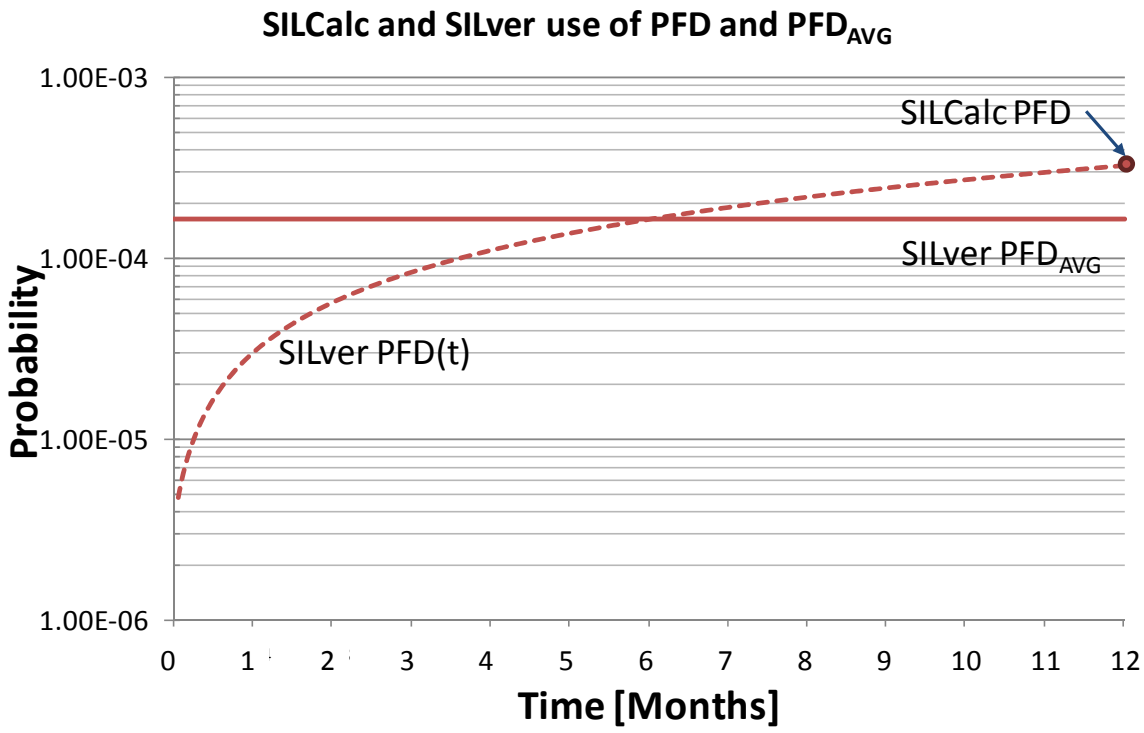
NOMENCLATURE

In some cases SILSuite SILCalc and exSILentia SILver use different terminology. The following provides an overview of terminology used in both tools and how these terms relate.

SILSuite SILCalc	exSILentia SILver
Unrevealed Failure Rate	Dangerous Undetected Failure Rate (DU)
Revealed Failure Rate	Safe Undetected Failure Rate (SU)
Test Coverage	Proof Test Coverage
Test Interval	Proof Test Interval
Test Duration	MTTR
Beta Factor (CCF)	Beta / Beta Factor
Maintenance Interval	Mission Time
Maintenance Duration	Startup Time

PFD VS. PFD_{AVG}

SILSuite SILCalc calculates the Probability of Failure on Demand (PFD) for a given configuration at a given point in time. exSILentia SILver calculates the Probability of Failure on Demand as a function of time (PFD(t)) and uses those results to calculate the average Probability of Failure on Demand (PFD_{AVG}). These are two different concepts one needs to be aware of. This is also identified in the subsequent figure for a simplified system.



USE SILSUITE SILCALC RESULT IN SILVER MYOWN

You can use the SILSuite SILCalc calculated Probability of Failure on Demand (PFD) in exSILentia by means of a MyOwn component. This MyOwn component will represent the system modeled in SILSuite SILCalc as a non redundant system. The input data for a MyOwn is in the form of a failure rate, consequently you need to use the calculated PFD to determine the configuration equivalent failure rate(s), i.e. number of failures per hour, for the MyOwn component. The following two formulas can be used:

$$\lambda^{DU} = \frac{-\ln(1 - PFD)}{730 * PTI} \qquad \text{Equation 1}$$

Where:
- λ^{DU}: = dangerous undetected failure rate (FailDU)
- ln: = natural logarithm function
- PFD: = SILSuite SILCalc calculated Probability of Failure on Demand
- PTI: = Proof Test Interval ***in months*** used in the SILSuite SILCalc calculation
- 730: = approximate number of hours per month (24*365/12)

$$\lambda^{DU} = \frac{PFD}{730 * PTI} \qquad \text{Equation 2}$$

Equation 1 represents the ***exact*** formula for calculating the dangerous undetected failure rate. Equation 2 shows an approximation formula that will yield an ***optimistic*** result, i.e. the dangerous undetected failure rate that is derived using Equation 2 will be lower than the dangerous undetected failure rate derived using Equation 1. exida encourages you using Equation 1, however Equation 2 may come in handy in a situation where you do not have a scientific calculator (or excel spreadsheet).

CAUTION

- Equation 2 yields an optimistic λ^{DU}. If your exSILentia SILver analysis yields a total PFD_{AVG} that is very close to a SIL boundary, you may actually pass that boundary with the exact λ^{DU}.
- PTI needs to be entered in months. If you use years the denominator needs to be multiplied with 8760 to convert to hours.

The λ^{DU} that results from either of the two equations can now be entered as the FailDU failure rate for the MyOwn component in exSILentia SILver.

MYOWN COMPONENT SELECTION

The MyOwn component is a placeholder in the exSILentia SILver equipment item dropdown boxes where you can enter your own failure rates. This selection is available from all equipment item dropdown boxes. See also the exSILentia User Guide for more details on the MyOwn component and its use.

How About a Mean Time To Fail Spurious Calculation?

SILSuite SILCalc only calculates the Probability of Failure on Demand. Consequently there is no resulting Mean Time To Fail Spurious (MTTFS) or Spurious Trip Rate determined for the calculation that you can easily transfer to the MyOwn Safe Undetected failure rate (FailSU).

If you are only interested in the safety integrity behavior of your Safety Instrumented Function, you can opt to leave the FailSU field of the MyOwn component empty. Note that the overall SIF MTTFS that will be calculated by exSILentia SILver will of course be optimistically higher since you excluded part of the spurious trips of this SIF.

If you want to include both the dangerous undetected and safe undetected failure rates in your analysis, you can use SILSuite SILCalc to also determine your "Probability of Failing Safe", note this is different than the already calculated Probability of Success on Demand (PSD). In order to do this you will need to enter the Safe Undetected Failure Rate or Revealed Failure Rate in the Dangerous Undetected or Unrevealed Failure Rate field. You will also need to modify the voting you selected. Once you have done this you can use the formula in Equation 3 to determine the safe undetected failure rate to be used for your MyOwn component.

$$\lambda^{SU} = \frac{-\ln(1 - "PFD")}{730 * PTI} \qquad \text{Equation 3}$$

Where:
- λ^{SU}: = safe undetected failure rate (FailSU)
- ln: = natural logarithm function
- "PFD": = SILSuite SILCalc calculated Probability of Failure on Demand which in this case represents the Probability of Failing Safe
- PTI: = Proof Test Interval ***in months*** used in the SILSuite SILCalc calculation
- 730: = approximate number of hours per month (24*365/12)

Note that you can also use a modification of Equation 2 to determine the safe undetected failure rates with the same optimistic result considerations as described above.

Voting Modification

Consider a 1oo2 voting between two valves. From a safety integrity perspective you only need 1 valve to be successful for your configuration to be successful. From a spurious trip protection perspective you will need both valves to be successful in order for your configuration not to have a spurious failure. For the calculation of the dangerous undetected failure rate you would enter a 1oo2 voting configuration. For the calculation of the safe undetected failure rate you would enter a 2oo2 voting confirmation.

Similarly a 2oo4 voting arrangements for a safety integrity perspective requires that 2 units are successful. To prevent a spurious trip 3 units need to be successful, after all if 2 units have a spurious trip you will go to the safe state. The Probability of Failing Safe calculation therefore needs to consider a 3oo4 voting.

As a general rule, a MooN voting for a safety integrity perspective will need to be modified to a (N-M+1)ooN voting for a spurious trip protection perspective.

Document Control

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